INSTRUCTION BOOK

MODEL 75A-S13

1 MC CAPACITANCE BRIDGE

SERIAL #338

Boonton ELECTRONICS Corporation

MORRIS PLAINS, NEW JERSEY

INSTRUCTION BOOK

MODEL 75A-S13

1 MC CAPACITANCE BRIDGE

SERIAL #338

R&W

Rodger Webster 8-21

The 75A-S13 differs from the standard 75A-S8 in that greatly increased resolution has been provided to enable the measurement of small values of capacitance when using low test signal levels.

Pages with supplementary schematic diagram and operating instructions have been inserted ahead of the main schematic diagram at the back of the book.

Boonton *ELECTRONICS* Corporation

738 SPEEDWELL AVENUE, MORRIS PLAINS, NEW JERSEY, U. S. A.

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I N S T R U C T I O N B O O K
M O D E L 75A-S8
C A P A C I T A N C E B R I D G E

The Model 75A-S8 Capacitance Bridge has all the features of the Model 75A Capacitance Bridge, plus an added source of dc bias voltage which can be applied to the component under test on "DIRECT" capacitance measurements only.

The "- OFF +" switch selects the desired bias polarity or removes the bias completely. A control for adjusting voltage level and tip jacks for voltage metering are also provided on the front panel. The maximum bias voltage available varies with the setting of the R/G switch as shown in the following table.

R/G Range	Approximate Maximum Bias Voltage	
	POS.	NEG.
1000	120	5
100	95	5
10	34	4.9
1	5	3.5

Whe the bias voltage is not required in the test it is advisable to turn the bias selector switch to the "OFF" position. By thus removing the DC voltage from the test, the possibility of over-voltage damage to the component is eliminated.

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75A 1 MC CAPACITANCE BRIDGE

INSTRUCTION BOOK

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SECTION I

MODEL 75A

SPECIFICATIONS

1.1 CAPACITANCE * : 0.001 to 1000 μμf in 4 decade ranges.

Multipl'r	Cap. Range	Smallest Division	Accuracy Direct	Accuracy Grounded
1	100-1000 μμf	0.2 μμf	±(0.25%+0.5μμf)	±(0.25%+1.0μμf
0.1	10- 100 "	0.02 "	±(0.25%+0.02 ")	±(0.25%+0.5 ")
0.01	1- 10 "	0.002 "	±(0.25%+0.005")	±(0.25%+0.5 ")
0.001	0- 1 "	0.0002 "	±(0.25%+0.001")	±(0.25%+0.5 ")

1.2 CONDUCTANCE * : 0.01 to 1000 micromhos in 4 decade ranges.

Divider	Cond. Range	Accuracy
1	100 to 1000 μmhos	$\pm(10\% + \frac{Q}{500}\% + 10\ \mu mhos)$
10	10 to 100 μmhos	$\pm(10\% + \frac{Q}{500}\% + 1\ \mu mho)$
100	1 to 10 μmhos	$\pm(10\% + \frac{Q}{500}\% + 0.1\ \mu mho)$
1000	0 to 1 μmhos	$\pm(10\% + \frac{Q}{500}\% + 0.01\ \mu mho)$

1.3 RESISTANCE *: 1000 Ω to 100 megohms in 4 decade ranges.

Multiplier		
1	1K to 10K	$\pm(10\% + \frac{Q}{500}\% + \frac{R}{10^3}\%)$
10	10K to 100K	$\pm(10\% + \frac{Q}{500}\% + \frac{R}{10^4}\%)$
100	100K to 1 megohm	$\pm(10\% + \frac{Q}{500}\% + \frac{R}{10^5}\%)$
1000	1 Megohm to ∞	$\pm(10\% + \frac{Q}{500}\% + \frac{R}{10^6}\%)$

Where R is the measured resistance in ohms.

These specifications apply to tests made at the HI and LO TEST posts. See Section V "Measuring Techniques" for limitations and tolerances applicable to remote measurements.

1.4 OPERATING FREQUENCY

With self contained oscillator and indicator	:	1 MC ± 10 KC
With external oscillator and indicator	:	100 KC to 1 MC

1.5 Signal Level across Test (at balance)	:	Adjustable from approximately 0.02V to 3 V
1.6 Tube Complement:		1-6C4, 3-6AU6, 1-6X4, 1-0A2.
1.7 Power Requirements:		105-125V, 50-60 CPS, 30 W.
1.8 Weight:		Cabinet 32 lbs; Rack 25 lb.
1.9 Size:		11 H x 19-5/8 W x 12¾ D (Overall in cabinet) 10½ x 19 x 9¾ depth behind the panel (rack mounted)

SECTION II

GENERAL DESCRIPTION

The Model 75A is an accurate, stable, and sensitive Capacitance Bridge, designed primarily to meet the need for precise measurements at a frequency of one megacycle. Either Direct or Grounded measurements may be made.

The basic virtues of its 100 KC equivalent, the BEC Model 74C, have been retained - namely, direct reading dials, self contained oscillator and indicator (for 1 MC operation), and power supply, excellent resolution and sensitivity, a high order of accuracy in measuring very small capacitance, and provision for differential measurements.

The versatile design additionally allows it to be used with an external oscillator and indicator at any frequency between 100 KC and 1 MC.

Provision for varying the level of the 1 MC test signal is standard. A modified version of the 75A (designated the 75A-S8) is available that provides a built-in adjustable D.C. bias for measuring the direct-capacitance of voltage variable semi-conductor diodes and other voltage sensitive capacitors.

SECTION III

DIRECT-CAPACITANCE VS. GROUNDED CAPACITANCE

Direct-capacitance is the capacitance existing between two conducting elements, excluding all stray capacitance that may exist to other conducting elements.

Typical examples of Direct-capacitance measurements are:

1. Capacitance between the control grid and plate of a pentode vacuum tube, excluding capacitance to cathode, screen grid, or suppressor.
2. Capacitance between any two conductors in a cable, excluding capacitance to all other conductors or the shield.
3. Capacitance between any two conductors of a printed circuit, excluding capacitance to all other conductors.
4. Capacitance between any two windings of a transformer, excluding capacitance to all other windings or shields.

Grounded capacitance is the capacitance existing between two conducting elements when one element is grounded, and includes all stray capacitance from the high side of the element to ground, either directly or by way of adjacent elements. For this reason, a Grounded capacitance reading will always be greater than a Direct-capacitance reading and will depend upon the proximity of the chassis, adjacent components, and measuring technique.

SECTION IV

OPERATING PROCEDURE FOR DIRECT OR GROUNDED MEASUREMENTS

4.1 SET UP AND ZERO BALANCING

1. Turn the power switch to ON. Select the desired method of capacitance measurement and set the selector switch to either GROUNDED or DIRECT. (See Section III).
2. Set the conductance range selector switch (marked DIVIDE G/ MULTIPLY R) to 1,000.
3. Set the MULTIPLY C switch to a position indicated in Table I on page 6.
4. Set the CONDUCTANCE dial to zero.
5. Set the CAPACITANCE dial to zero. (Both vernier and counter dials should read zero).
6. If they are required, connect test leads or fixture. (IMPORTANT: Read Section V "Measuring Techniques" before proceeding).
7. Adjust zero balance controls (located to the right of the main CAPACITANCE and CONDUCTANCE dials) until the NULL INDICATOR meter reads zero. FINE capacitance zero control should be set with pointer in vertical position before adjusting COARSE control. INDICATOR SENSITIVITY control should be set to approximately three o'clock. Too high a control setting will result in unnecessary difficulty in obtaining a null indication: too low a setting will reduce measuring accuracy.

TABLE I

Capacitance Range	"MULTIPLY CAPACITANCE" Control Setting
1,000 - 100 μμf	1
100 - 10 μμf	0.1
10 - 1 μμf	0.01
1 - 0 μμf	0.001

4.2 MEASURING

1. Connect test specimen to the HI and LO TEST posts (to test leads or fixture, if used), utilizing appropriate techniques as described in Section V.

2. Adjust CAPACITANCE and CONDUCTANCE dials until meter indicates best null. For best accuracy the null should obtain between 100 and 1,000 on both the CAPACITANCE and CONDUCTANCE dials. If it appears above or below these values, the next indicated MULTIPLY CAPACITANCE and/or DIVIDE G/MULTIPLY R range should be used.

NOTE:

Whenever the capacitance or conductance ranges are changed, the capacitor to be measured must be disconnected and the bridge zero balanced as detailed in paragraph 4.1.

4.3 INTERPRETING READINGS

1. After balancing both capacitance and conductance to a satisfactory degree of precision, the capacitance of the test specimen is determined directly from the CAPACITANCE dial reading, multiplying by the decimal factor indicated on the MULTIPLY C knob.

2. The conductance of the test specimen is found be dividing the reading indicated on the G scale of the conductance dial by the factor indicated on the DIVIDE G/MULTIPLY R dial. On the X1 Capacitance Range a correction factor for conductance must be taken into account as shown in Figure 1, Page 7. Red dial markings extending from zero

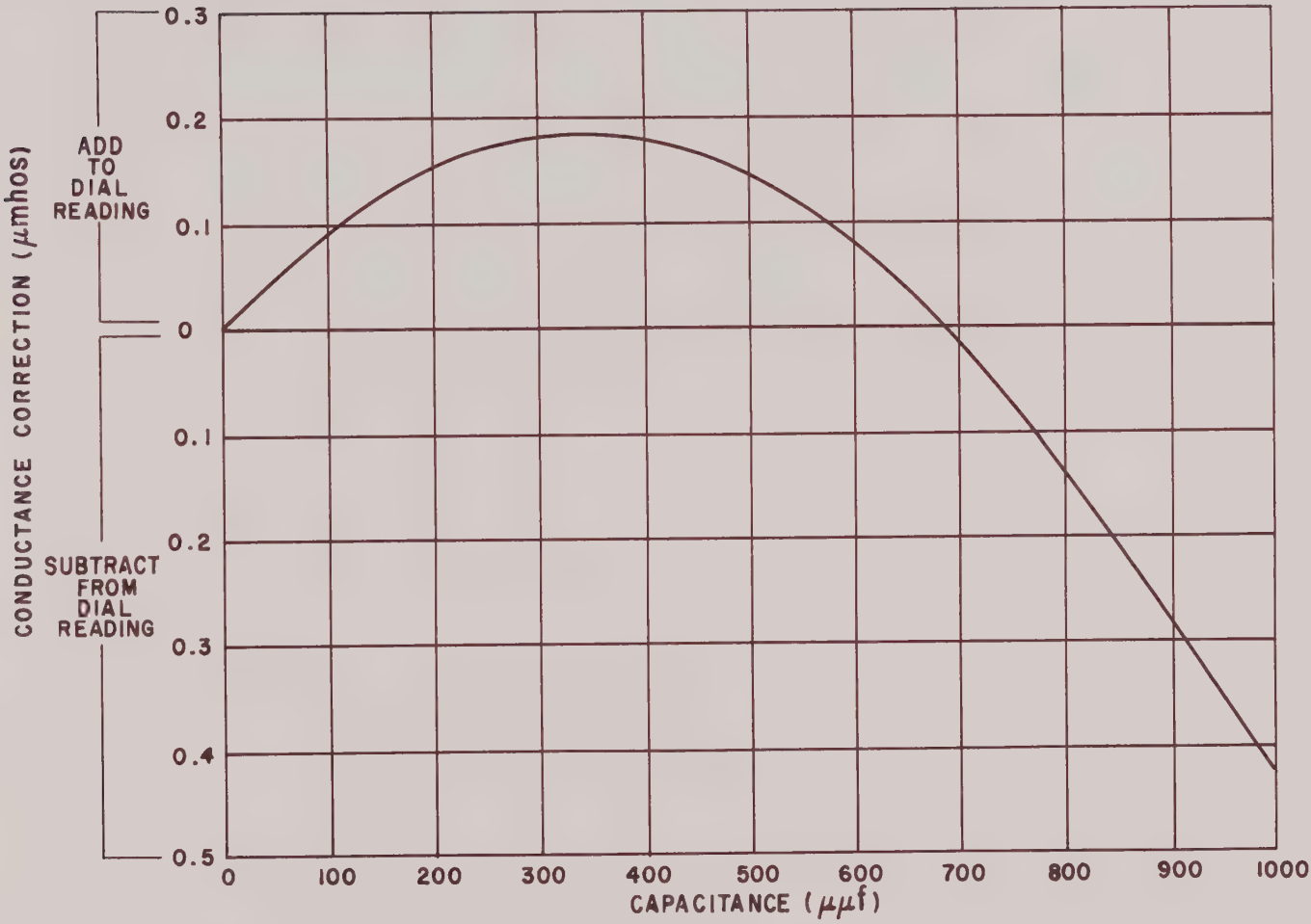

FIGURE 1

CONDUCTANCE CORRECTION
FOR X1 CAPACITANCE RANGE

75A IMC CAPACITANCE BRIDGE

to minus 100 have been provided to facilitate measurements when the null is obtained with the CONDUCTANCE dial below zero.

3. Except on the X1 capacitance range, the equivalent shunt resistance is determined by multiplying the reading indicated on the R scale by the factor shown on the DIVIDE G/MULTIPLY R dial. On the X1 capacitance range the most accurate procedure is to determine the conductance as outlined in 4.3.2, then divide that figure into 1 to obtain the equivalent shunt resistance. ($R = \frac{1 \times 10^6}{G}$ where G is in micromhos).

4. The Q and Dissipation Factor, D, of the test sample may be computed from the following formulae:

$$Q = \frac{2\pi fC}{G}$$

At 1 MC

$$Q = 6.28\,\frac{C}{G} \qquad D = \frac{1}{Q}$$

Where C = test specimen capacitance in μμf.
G = test specimen conductance in micromhos.
f = frequency in megacycles.

SECTION V

MEASURING TECHNIQUES (See also Appendix A)

5.1 GENERAL

When using a test frequency of 1 MC, the effect of added lead length between the bridge and the test specimen cannot be neglected. The resulting error is primarily due to the lead inductance and resistance.

For capacitance values above about 50 μμf, increased lead length produces higher readings of both capacitance and conductance. Using the Direct method of measurement and with RG-58/U coaxial cables connecting the test specimen to the bridge, each foot of extension of the two leads will increase the readings approximately as given in Table II.

TABLE II

Capacitance to be measured	Approximate increase in reading for 1 ft. extension of test leads using RG-58/U coax. cables only.	
	C	G
1000 μμf	+ 0.8% (8 μμf)	+ 4 μmhos
500 μμf	+ 0.4% (2 μμf)	+ 1 μmho
100 μμf	+ 0.1% (0.1 μμf)	+ 0.05 μmho

Below 50 μμf the error due to lead inductance and resistance becomes relatively small, and the principal effect of remote testing is the reduction of sensitivity owing to the shunting effect of the coaxial lead capacitance. In general, up to three ft. of RG-58/U cable extension may be used without noticeable effect.

Whenever feasible, the Direct method of measurement should be used because it greatly reduces hand capacitance effects as well as the test specimen position error which are basic limitations when making grounded measurements.

5.2 DIRECT-CAPACITANCE MEASUREMENTS

1. If measurements are to be made at the HI & LO TEST binding posts, the test specimen should be connected as close as possible to these posts. All other conductors in the immediate vicinity of the elements under test must be connected to ground using the GND binding post on the front panel.

   In many cases it may be more convenient to insert the wire leads of the test specimen directly into the center conductor receptacle of the HI & LO coaxial TEST jacks. This is particularly useful with smaller mica, ceramic or voltage variable types of capacitors and has the advantage that the outer shell of each jack shields the leads from each other for much of their length.

2. When measurements are to be made at the end of coaxial cables the following procedure should be used:

   Connect the coaxial cables to the BNC HI & LO TEST receptacles and the center conductor of the LO cable to the test specimen. If other conductors are to be grounded, the shield braid of the coaxial cables may be used as a convenient ground connection. Keep the exposed portion of the center conductor of the HI cable away from the test specimen, and balance the bridge as described in paragraph 4.1 (Section IV). (1)

   Connect the HI coaxial cable to the test specimen and measure.

   (1) The small offset of both capacitance and conductance zeros that results when coaxial cables are connected to the TEST receptacles is normal when operating at 1 MC. If the bridge is operated at 100 KC (as in the 74C), this effect is negligible.

When measuring small capacitance, the length of unshielded test lead should be kept to an absolute minimum ($\frac{1}{8}$ inch or less) for greatest accuracy. Also, the test leads should be kept as far as possible from the field of the capacitance under test. In some cases it may be necessary to provide a jig for connection purposes that will completely shield and eliminate the test lead capacitance.

5.3 GROUNDED CAPACITANCE MEASUREMENTS

Grounded capacitance measurements are inherently less accurate than Direct-capacitance measurements owing to unavoidable stray capacitance variations between the HI test lead and ground.

Although these variations may amount to 1 μμf or more, it is usually possible to reduce this uncertainty to less than 0.5 μμf by using the following procedure when preparing a test specimen:

1. Connect the ground side of the test to the LO binding post using a short length of wire.

2. Connect a short length of bare tinned copper wire to the HI binding post. Bend this wire so it approaches the test sample perpendicularly and is spaced away from all surrounding objects as much as possible. The free end should be spaced approximately 1/4 inch from the high terminal of the sample for bridge zero balance adjustments. The final measurement is made with this wire connected to the test specimen.

Contact fixtures may be used for production testing provided their residual capacitance does not exceed the range of the COARSE and FINE controls (approx. 10 μμf).

5.4 DIFFERENTIAL MEASUREMENTS

In addition to the normal TEST connections on the front panel, BNC receptacles marked STANDARD ARM have been provided for access to the arm of the bridge opposite that to which a test specimen is connected.

For either differential or temperature coefficient measurements the reference capacitor is connected to the STANDARD ARM via the BNC receptacles and the test specimen to the TEST BNC receptacles. It is usually desirable to keep the connecting coaxial cables of equal lengths to both capacitors.

If the reference capacitor is adjusted at the start of the test to equal the one being tested, the bridge can then be set to a capacitance range that will give the desired resolution. For example, if a 100 μμf ceramic capacitor with a negative T.C. of 300 P.P.M./°C is to be tested to verify its T.C., a set up can be made with an adjustable air trimmer connected to the STANDARD ARM cables, and the ceramic capacitor connected to the TEST cables. The ceramic capacitor may be in a temperature chamber while the air trimmer is kept at a fixed temperature.

The capacitance of the air trimmer can now be set to equal that of the ceramic, and the bridge switched to the X.01 or X.001 capacitance ranges depending on the desired range of capacitance change to be observed. If the X.001 range is selected and the T.C. is nominal, a 30°C change of capacitor temperature should result in a 1 μμf capacitance change (full scale deflection). Alternately, if the X.01 range had been selected, coverage would have been 1/10 of full scale.

With the connections previously described, the bridge reading will be direct sensing; that is, an upscale reading indicates an increase of capacitance of the test specimen.

When testing capacitors of 10 μμf or less for T.C., an external capacitor on the STANDARD ARM is unnecessary since the C ZERO COARSE and FINE controls can be used for that purpose.

When the highest possible stability is required for critical T.C. measurements, it is best to leave the bridge on continuously.

SECTION VI

MAINTENANCE

6.1 GENERAL

This capacitance bridge has been carefully calibrated at the factory against three-terminal capacitance standards certified by the National Bureau of Standards. Unless comparable standards are used, re-calibration of this instrument by other than the manufacturer is inadvisable.

Calibration is not affected by removing the bridge from the cabinet or by replacing tubes. The shield over the bridge section, however, should not be removed.

6.2 TUBE REPLACEMENT

Tubes need not be replaced until they cease to perform satisfactorily. If there is a question as to performance, new tubes may be substituted to check for improvement, or they may be checked on any good tube tester.

No tube selection is necessary.

The 6C4 1 MC oscillator tube is accessible by removing the top cover of the oscillator shield. When replacing this cover be sure to tighten the holding screws to prevent leakage.

6.3 NORMAL OPERATING VOLTAGES.

Table 4

Conditions:

115V 60 cycle line input.

Bridge balanced.

AC/DC Multimeter with d-c sensitivity of 20,000 ohm/V.

RF Voltmeter, such as Boonton ELECTRONICS Corp. Model 91C.

Test Points	Normal Rdg.	Notes
V5 (6X4) Pin 7 (cathode) to chassis	270-290V D.C.	
V6 (0A2) Pin 5 (plate) to chassis	145-155V D.C.	
V1 (6C4) Pin 5 (plate) to chassis	220-240V D.C.	OSC level switch on HI, OSC LEVEL ADJUST fully clockwise.
V2, 3,4 (6AU6) Pin 5 (plate) to chassis	230-260V D.C.	
" Pin 6 (screen) to chassis	130-150V D.C.	
" Pin 3 (heater) to Pin 4	6.0-6.6V A.C. (60 cycle)	
J1 Oscillator output.	1.0-1.5V A.C. (1 MC)	

6.4 1 MC OSCILLATOR AND INDICATOR CHECKS AND ADJUSTMENT.

1. Overall check.

The correctness of operation of the oscillator and indicator may be conveniently tested by an overall check of NULL INDICATOR meter deflection for a known amount of bridge unbalance.

To do this, switch to DIRECT, X1000, and X.001. Turn the INDICATOR SENSITIVITY control fully on and the CAPACITANCE & CONDUCTANCE dials to zero. Carefully balance the bridge, using the C ZERO COARSE and FINE, and R/G ZERO controls.

Turning the CAPACITANCE dial 1 μμf (effective change being 0.001 μμf) in either direction from balance should produce an increase in NULL INDICATOR meter reading of at least 20 μa.

If less change in meter reading obtains, the oscillator and/or indicator may require re-alignment.

2. Alignment

To re-align the oscillator and indicator circuits, switch to DIRECT, X1000, and X1. Turn the CAPACITANCE & CONDUCTANCE dials to zero and the INDICATOR SENSITIVITY control fully on. Balance the bridge using the C ZERO COARSE and FINE, and R/G ZERO controls.

Now, unbalance the bridge for a meter reading of about 15 μa, and then adjust the OSC FREQ control for maximum meter reading. An appreciable increase in meter reading may indicate that the insensitivity has been overcome which can readily be determined by repeating step 6.4.1 "Overall Check".

If the procedure of 6.4.2 did not improve the sensitivity, the indicator should be checked, peaking each circuit of T4, T5, T6, and T7 for a maximum meter reading (keep the meter at about 15 μa by nearly balancing the bridge). Repeat step 6.4.1.

The final alignment step requires an RF Voltmeter suitable for use at 1 MC. Switch the OSC LEVEL toggle switch to the LO position. Connect the voltmeter between the LO TEST post and the ground post, and adjust the oscillator FILTER ADJ. control for maximum reading on the RF voltmeter. The reading should be about 1V RMS. Restore the OSC LEVEL switch to the HI position.

Repeating step 6.4.1 should now give at least a 20 μa/dial μμf reading on the NULL INDICATOR meter.

3. Oscillator Frequency

The oscillator frequency has been factory adjusted to be within a few KC of nominal. If it is necessary to re-adjust the frequency, it should be done with the oscillator connected normally to the bridge, which has been allowed to warm up for

at least one half hour.

Any standard method of determining frequency may be used, such as a frequency counter or crystal calibrator.

4. Indicator Sensitivity

Indicator sensitivity can be checked with a well shielded Signal Generator having low output impedance and a calibrated attenuator. Connect the generator by coaxial cable to J2. With the INDICATOR SENSITIVITY control fully clockwise, determine the input level required for a NULL INDICATOR meter reading of 25 µa. Normal input level is approximately 0.5 microvolts.

6.5 BRIDGE CIRCUIT

1. Conductance

To check the operation of the conductance measuring circuit, first set the DIVIDE G/MULTIPLY R and the MULTIPLY C switches at 1 and the CAPACITANCE dial at zero. The R/G ZERO control should be set near mid-rotation (approx. 2¼ turns from either stop).

Next, balance the bridge using the COARSE and FINE capacitance controls and the main CONDUCTANCE dial. Balance should be reached with the CONDUCTANCE dial at or near zero (within ONE DIAL DIVISION, i.e. ± 10 µmhos).

With the CONDUCTANCE dial at the setting that yields balance on the X1 DIVIDE G/MULTIPLY R range, it should be possible to achieve a conductance balance on other DIVIDE G/MULTIPLY R ranges, in either DIRECT or GROUNDED positions of the GROUNDED/DIRECT switch, using only the R/G ZERO control and the COARSE and FINE capacitance controls. (Do not connect any cables or test fixtures to the bridge while making this test).

A quick test of operation on all DIVIDE G/MULTIPLY R ranges may be performed using 1K, 10K, 100K and 1 megohm, 1/4 watt, ± 1% deposited carbon resistors.

a. First, set up the bridge as detailed in the first two paragraphs of 6.5.1. Then, connect the 1K resistor between the HI & LO TEST posts and balance the bridge using the CONDUCTANCE and CAPACITANCE dials. Read the indicated value on the CONDUCTANCE dial.

b. Remove the 1K resistor, switch to "10" on the DIVIDE G/ MULTIPLY R control, turn the main CAPACITANCE and CONDUCTANCE dials to zero and re-balance using the R/G ZERO control and the COARSE and FINE capacitance controls. Connect the 10K resistor and again balance using the CONDUCTANCE and CAPACITANCE dials. Read the indicated resistance value on the CONDUCTANCE dial and multiply by 10.

c. Repeat the procedure on the X100 and X1000 ranges using the 100K and 1 megohm resistors, respectively. In all cases, readings should fall within ± 11% of full scale on the CONDUCTANCE dial.

6.5.2 Capacitance

The variable capacitor has been very accurately balanced and adjusted at the factory to insure tracking to the CAPACITANCE dial calibration. This operation requires special equipment and techniques, and should not be attempted in the field.

If it is necessary to standardize the capacitance calibration (by measuring capacitance standards), the bridge should be operated at 100 KC with an external oscillator and indicator. At this frequency the effects of lead inductance and cable capacitance are greatly reduced.

The calibration obtained by standardizing at 100 KC will hold for 1 MC measurements at the HI & LO TEST posts, with the exception that on the X1 capacitance range, only, slightly greater accuracy can be secured by applying the following corrections for the effects of internal lead inductance:

Table 5

CORRECTION FOR INTERNAL INDUCTANCE: X1 CAPACITANCE RANGE ONLY

CAPACITANCE DIAL RDG (μμf)	50	100	200	300	400	500	600	700	800	900	1000
CORRECT RDG BY ADDING: (μμf)	+0.03	+0.2	+0.25	+0.05	0.0	-0.05	-0.2	-0.4	-0.7	-1.0	-1.6

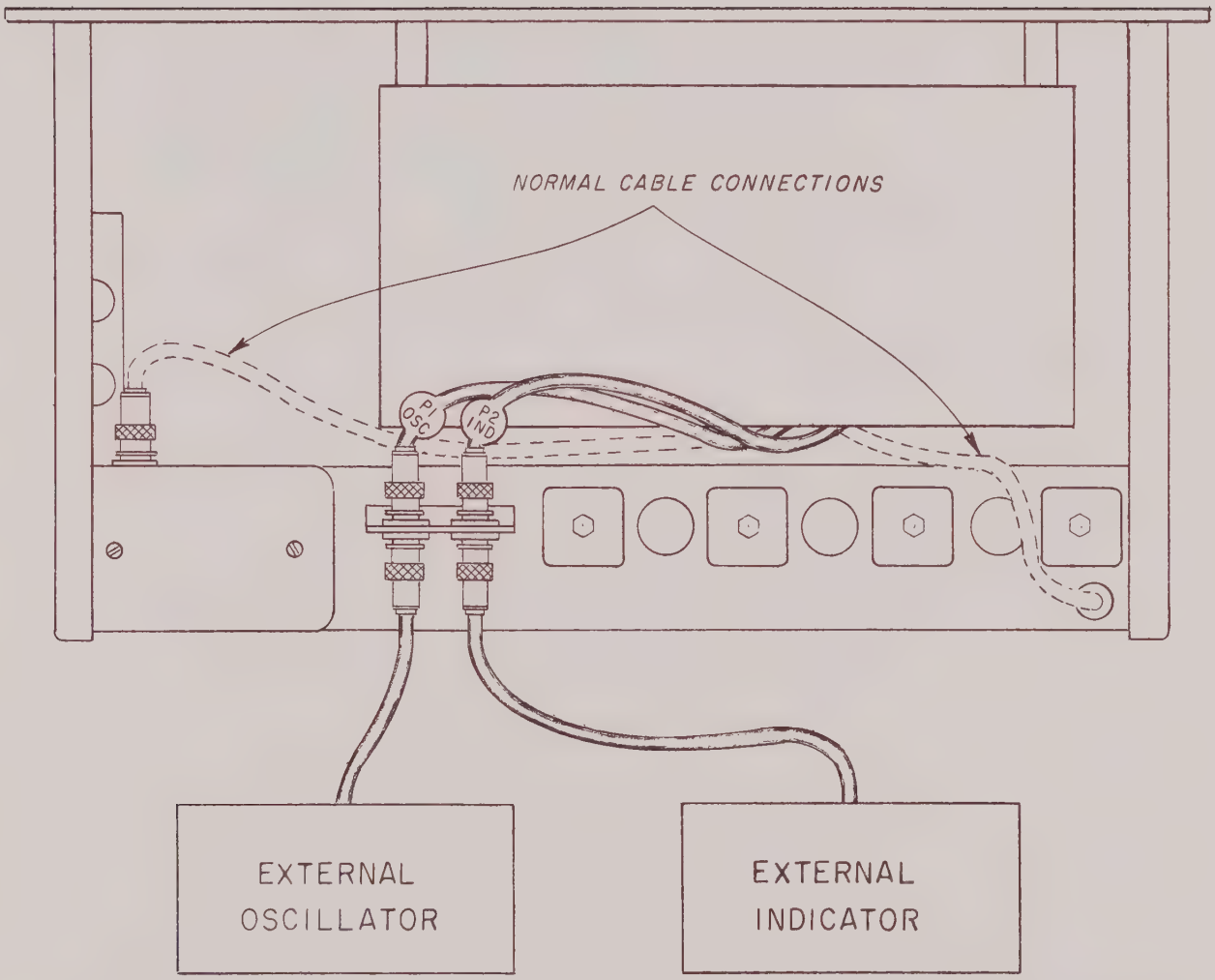

FIGURE 2

CONNECTIONS FOR USE WITH EXTERNAL OSCILLATOR AND INDICATOR

7.1 OSCILLATOR REQUIREMENTS

An external oscillator to be used with the 75A should cover the desired operating frequency, be capable of delivering at least 1V into a 16 Ω load, have a low internal impedance, and be well shielded to avoid direct pick-up by the indicator.

Harmonic distortion need not be very low except when the 75A is to be used for testing semiconductors. For this use it should not exceed 1%, and preferably 0.1%.

7.2 INDICATOR REQUIREMENTS

An external indicator for use with the 75A must have high gain at the test frequency, good signal-to-noise ratio, and good shielding against external pick-up. If a receiver is used, it may have a B.F.O. for the indication of an unmodulated signal, or may be used with a tone modulated oscillator.

Although it may be omitted in many cases, a simple matching transformer is desirable between the low impedance of the bridge output transformer and the receiver input. Proper matching will increase the usable indicator sensitivity and give greater measuring resolution.

SECTION VIII

WARRANTY

Boonton ELECTRONICS Corporation guarantees to the original purchaser that each instrument it manufacturers be free from defects in material and workmanship for a period of one year after date of initial shipment. Our liability is limited to repairing or replacing any defective part with the exception of vacuum tubes, panel lamps, fuses, choppers, and batteries. The warranty lapses if, upon our examination, we judge that the instrument has been abused in any way.

PROCEDURE TO FOLLOW WHEN INSTRUMENT IS DEFECTIVE

1. Call our plant or our representative nearest you. A simple solution may result from discussion of the problem with our trained personnel.
2. If the fault is not readily eliminated, prepare the instrument for return to us. Pack carefully in a sturdy container using several inches of shock absorbing material on all six sides of the instrument. Include all probes, cables, or accessory units. On all paper work pertaining to the returned instrument, note the model and serial number and state briefly the details of the fault. Ship to us transportation charges prepaid.
3. If the instrument is within the warranty, we will repair and return to you transportation charges prepaid. If the instrument is beyond the one year warranty period, we will repair and return it unless approval on a cost estimate is requested. If the instrument is within the one year warranty period, but our examination reveals abuse, we will await approval of our cost estimate before proceeding with repairs.

SECTION IX

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SECTION X

TABLE OF REPLACEABLE PARTS

Note:

Components in the "Bridge" unit have not been included, since in general their replacement must be followed by adjustments that require specialized equipment and techniques.

C1	Capacitor, sil. mica	56 μμf ± 1%	Arco DM15F560F
C2	Capacitor, ceramic, Zero T.C.	3.3 μμf ± .25μμf	CRL TCZ-3R3
C3,4, 5,40,41	Capacitor, ceramic	0.05 μf 0 + 100% 500 W.V.	Glenco CBM-.05-3
C6,7	Capacitor, ceramic	0.1 μf 0 + 100% 500 W.V.	" CBM-.1 -3
C8 thru 19	(in bridge)		
C20	Capacitor, sil. mica	5100 μμf ± 5%	Arco DM20F512J
C21 thru 26	" " "	200 μμf ± 5%	" DM15F201J
C27	" " "	100 μμf ± 5%	" DM15F101J
C28,30,32,34, 36,38	Capacitor, paper	0.01 μf ± 20% 400 W.V.	
C29,33,37	Capacitor, met. paper	0.1 μf ± 20% 200 W.V.	
C31,35,39	Capacitor, paper	0.05 μf ± 20% 400 W.V.	
C42	(in bridge)		
C43	(not used)		
C44	Capacitor, electrolytic	20-20 μf/450 W.V.	Mallory FP-234
D1	Diode	1N34A	
F1	Fuse	0.5A	Buss AGC-.5
L1,2	Choke, RF	2.5 mh 200 ma	Miller 6302
L3,4	Choke, Iron core, RF	55 μh 300 ma	Miller 4629
L5	Choke, power	7 hy 50 ma	Stancor C1707
L6	Choke, RF	Special	BEC 400,026

M1	Meter, Special scale	200 µa	BEC 554,116
R4,19,20,21,22,24,25,26, 27,28,29,31.	Resistor, composition	±5% ½W	AB Type EB
R1,2,17,23,30	Resistor, composition	± 10% ½W	AB Type EB
R3,5	" "	± 5% 1W	AB Type GB
R33	" "	±10% 1W	AB Type GB
R6	" variable	50K Ω 2W linear	AB Type J
R18	" "	10K Ω 2W linear	AB Type J
R34	" W.W.	7.5K Ω ±10% 10W	Mallory 1HJ 7500
R7 thru R16 (in bridge)			
R32	(Not used)		
S1	Switch, toggle	DPDT	AH&H 81027 AZ
S2,3,4, (in bridge)			
S5	Switch, toggle	DPST	Carling 216-62
T1	Transformer, Osc.		BEC 075,010
T2,3	(in bridge)		
T4	Transformer, IF	Special	BEC 075,006
T5,6	" "	"	BEC 075,007
T7	" "	"	BEC 075,008
T8	" power		Stancor PC8401
V1	Tube	6C4	
V2,3,4,	"	6AU6	
V5	"	6X4	
V6	"	0A2	

SUPPLEMENTARY OPERATING PROCEDURE

This bridge as shipped has the 75-1A 40 db attenuator installed, and has been factory adjusted for optimum operation at low TEST signal levels.

A. Suggested Procedure for Optimum Indicator Peaking

(Normally required only when operating with low levels of TEST signal and when greatest possible sensitivity is required).

1. Set the MULTIPLY C switch to .001, DIVIDE G/MULTIPLY R on 1000, OSC LEVEL controls for maximum test signal, GROUNDED-DIRECT switch on DIRECT, and the INDICATOR SENSITIVITY control nearly full on. Balance the bridge.

2. Trim FILTER ADJUST for maximum signal level at the LO TEST coaxial receptacle.

3. Connect the 75-1A 40 db fixed attenuator between J1 and P1. Switch OSC LEVEL to LO and (using the OSC LEVEL ADJUST) set the test signal level on the LO TEST receptacle to 2mv.

4. Again balance the bridge, then turn the CAPACITANCE dial up scale for a NULL INDICATOR meter reading of about 10 μa.

5. Carefully adjust the trimmers of T7, T6, T5, T4 and the IND PEAK control for maximum NULL INDICATOR meter reading. A CAPACITANCE dial change of 40 mmf. should now produce a NULL INDICATOR meter reading of at least 10 μa.

B. Adjustments for Optimum Resolution

1. On the .001 and .01 MULTIPLY C range the following procedure should be followed.

   a. Set the bridge controls to the desired MULTIPLY C range, the DIVIDE G/MULTIPLY R switch to 1000 and the GROUNDED-DIRECT switch to DIRECT. Adjust the OSC LEVEL controls for the desired TEST signal level as measured at the LO TEST jack.
   b. Connect the test fixture to the bridge. (Note that the capacitance between the HI & LO TEST posts to ground should be kept as low as possible).
   c. Balance the bridge.
   d. Turn the CAPACITANCE dial a few mmf. (for a meter reading of about 20 or 30 μa).
   e. Turn the IND PEAK trimmer (located at the right of OSC LEVEL) for maximum meter reading. (Approximate position of the white dot on the IND PEAK knob should be ● 1:30

o'clock for the .001 range and 1:00 for the .01 range. This position moves counter-clockwise in proportion to any capacitance that the fixture adds between the HI post and ground).

f. Again balance the bridge.

2. On the .1 and 1 MULTIPLY C ranges it is not possible to remove enough capacitance by the trimmer to actually peak, but best results will obtain when the trimmer is set to minimum (dot @ 9:00 o'clock).

3. If increased resolution is desired on the .1 and 1 MULTIPLY C ranges, it may be obtained by re-peaking the trimmer of T4. However, there is some interaction between the IND PEAK trimmer and that of T4. Hence when it is desired to return to the .01 or .001 ranges, the IND PEAK trimmer should first be set to 1:30 o'clock if on the .001 range or 1:00 if on the .01 range, and then the trimmer of T4 used for peaking.

C. Tuning the Series Resonant Trap, L6/C20 (located below and to the right of J1, and marked FILTER ADJ).

This (normally a factory adjustment) is tuned for maximum test signal between LO and GND TEST posts. It should preferably be adjusted with the OSC LEVEL controls set for maximum test signal, and without the 75-1A 40 db Fixed Attenuator. See preceding paragraph A.2.

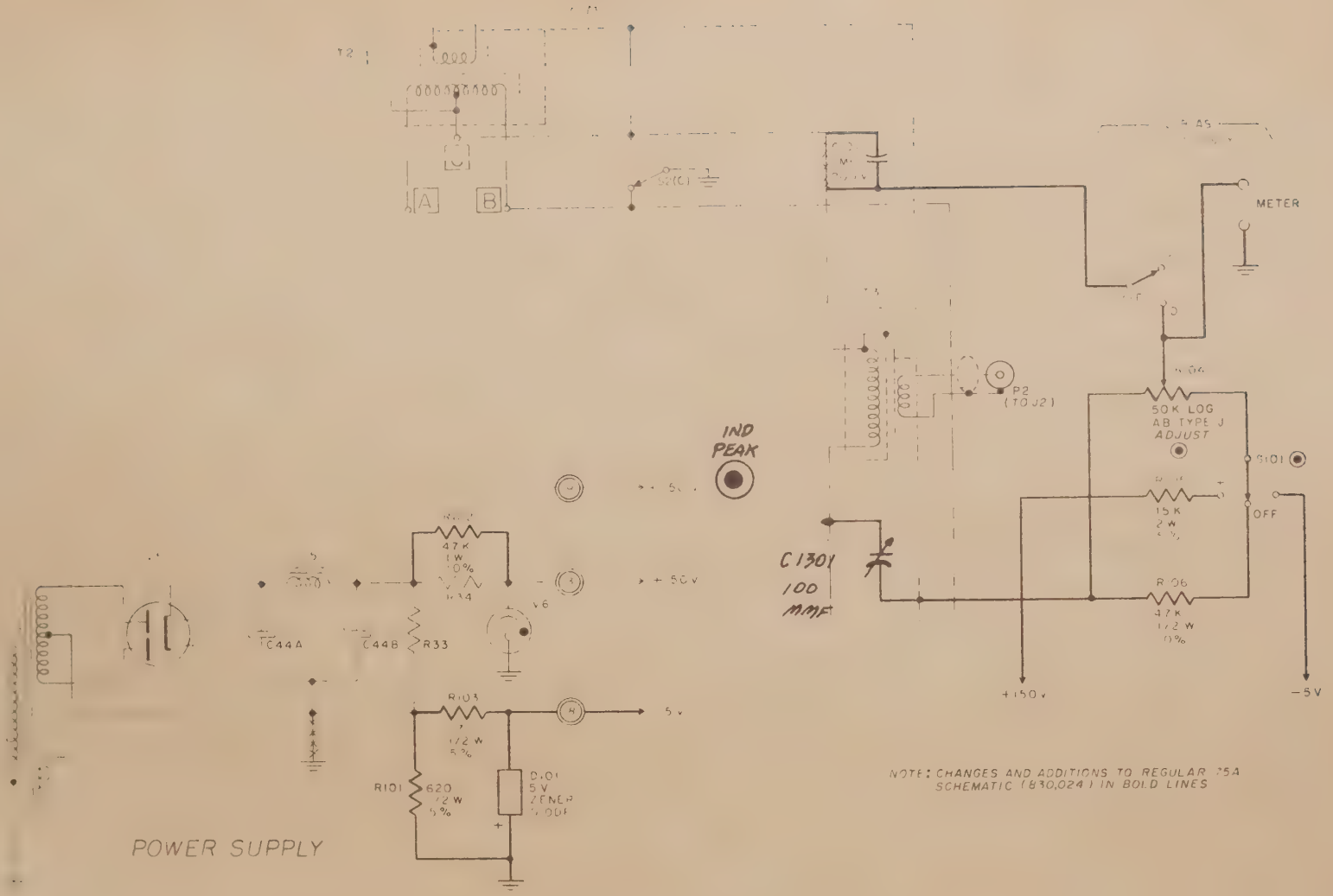
B 75-1A 40 db Fixed Attenuator

(To be connected between J1 & P1)

This attenuator should be used whenever it is necessary to operate at test signal levels below approximately 25 millivolts. It has been designed specifically to give the desired attenuation without destroying the harmonic reducing properties of the series resonant trap.

Note:

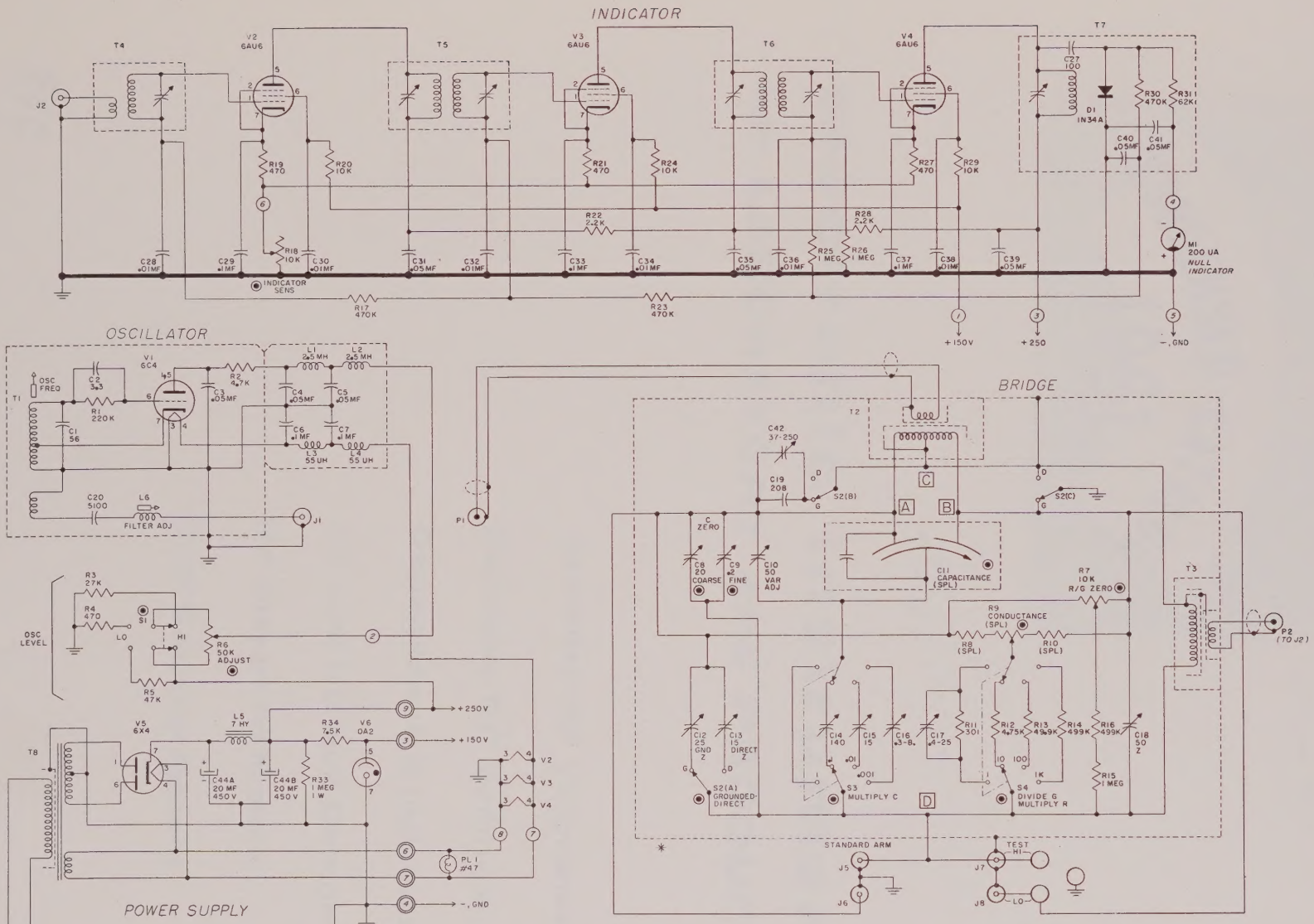
The tuning of the bridge output transformer restricts bridge operation to 1MC, except when reduced resolution is acceptable.



NOTE: CHANGES AND ADDITIONS TO REGULAR 75A SCHEMATIC (830,024) IN BOLD LINES

SUPPLEMENTAL SCHEMATIC
CAPACITANCE BRIDGE
MODEL 75A-[redacted] S13
BOONTON ELECTRONICS CORP

[redacted]
830,038A



SCHEMATIC DIAGRAM
CAPACITANCE BRIDGE
MODEL 75A

BOONTON *ELECTRONICS* CORP
MORRIS PLAINS, N J

830,024E

CAPACITANCE IN MMF UNLESS NOTED
RESISTANCE IN OHMS (K=1,000)
⏚ = PANEL GROUND
✱ = BRIDGE SHIELD (SEE S2-C FOR CONNECTIONS)
(1) = PIN # ON P3 & J3
(1) = PIN # ON P4 & J4
◉ = PANEL CONTROL
OSCILLATOR & INDICATOR FREQ ≑ 1 MC

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